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ANTARCTICA AS A MODEL FOR THE HUMAN EXPLORATION OF MARS

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Antarctica as a Model for the Human Exploration of Mars

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SUMMARY

Problem

In planning for the human exploration of Mars, an understanding of the processes of social adaptation and individual adjustment to prolonged isolation in an extreme environment is required, particularly from the standpoint of personnel selection, crew organization, and task performance. Data from previous space missions, however, is limited for a number of reasons.

Objective

The purpose of this paper is to examine the utility of the experience of human exploration and habitation in the Antarctic as a model for the human exploration of Mars with a focus on patterns of adaptation and adjustment.

Approach

This examination is divided into three sections. The first section provides a brief overview of the history of exploration in the Antarctic. The second section summarizes the contemporary experience of Antarctic winter-over personnel. The paper concludes with an examination of the relevance of that experience for a manned mission to Mars.

Results

An examination of the history of Antarctic exploration indicated that each phase of activity was marked by improvements in technology, transport, communications, and habitations as well as changes in organizational structure and mission objectives. All of these factors had a profound influence on patterns of adaptation and adjustment. Factors which currently influence processes of social adaptation and individual adjustment in the Antarctic include social organization, "Antarctic culture," social and psychological resources used for coping with stress, and environmental resources and constraints. Adaptation and adjustment reflect a synergistic effect of physical and emotional stressors. Criterion measures of adaptation and adjustment are interrelated.

Conclusion

A diachronic perspective on exploration is essential for it demonstrates that certain aspects of the processes of adaptation and adjustment change over time while others remain relatively constant. The utility of the human experience in Antarctica as an analog for extended manned missions to Mars must be evaluated on the basis of the degree of similarity or difference of a number of factors believed to influence adaptation and adjustment in the two contexts. The criteria used to assess adaptation and adjustment are based on two different and at times contradictory sets of definitions, one which is organizational and normative, and one which is operational and pragmatic.

Recommendations

Further research on the utility of Antarctica as a model for extended manned space missions must evaluate the comparability of factors influencing adaptation and adjustment in the two contexts.

Antarctica as a Model for the Human Exploration of Mars

Introduction

In the event that a manned mission to Mars does take place, an understanding of human factors involved in such a mission will be critical in the planning, operational, and post-mission phases. The research requirements for such an understanding have been well documented in previous studies (c.f., Brady, 1983; Christensen and Talbot, 1986; Harrison and Connors, 1984; Connors, Harrison, and Atkins, 1985; Kanas, 1985; National Academy of Sciences, 1972; Sells and Gunderson, 1971). Much of the data for such research has come from the experience of previous U.S. and Soviet manned missions (Beregovoy, 1979; Bluth, 1981; Leonov and Lebedev, 1973). However, such data are not without their limitations, including the small number of cases available for study, limited information on the emotional state and performance of crews in American space missions (Kanas, 1985), differences in organization and mission requirements over time (Christianson and Talbot, 1985), and reluctance of the American space community to engage in psychological research (Connors, Harrison, and Atkins, 1986; Harrison, 1986).

Moreover, an endeavor such as the human exploration of Mars is terra incognita in both a behavioral as well as literal sense. By its very nature, exploration in any form is a journey into the unknown, filled with uncertainty and anxiety, and requiring considerable initiative, courage, independence, and physical and psychological stamina. Preparation for such an experience calls for the identification of environmental, social, cultural and psychological parameters of the mission in addition to technological resources and constraints. These parameters can be determined by utilizing what we know about human nature, particularly with respect to social interaction, task performance, cognition, and coping with stress. They may also be determined with the assistance of analog experiences, situations which share many of the anticipated parameters of a long-term space flight and planetary expedition.

Several different analogs have been used to identify these system parameters, including undersea labs, submarines, offshore oil platforms and supertankers. One of the most suitable analogs, however, is the human experience in Antarctica. Isolated for prolonged periods in an extreme environment, Antarctic winter-over personnel may help to identify the para-

meters necessary for planning, crew selection, and organizational requirements for a manned mission to Mars.

Antarctica has been used in previous studies as a model for the analysis of human factors involved in long-term space missions (Connors, Harrison, and Atkins, 1985; Kanas, 1985; Sells and Gunderson, 1971; Stuster, 1984). An aspect of the human experience in Antarctica particularly relevant to a manned mission to Mars is the processes of adaptation and adjustment and their relationship to health and performance. Adaptation is the process by which an individual or group makes certain behavioral or biological adjustments in response to the demands of a social and physical environment. This adjustment may be temporary (proximate adaptation) or it may have long-term implications for behavior (ultimate adaptation). Typically, adaptation is defined in terms of a set of criteria or measures. In the Antarctic, three sets of criteria have traditionally been used to assess the extent to which one has adapted to the environment: physical and emotional health, task performance, and social compatibility (Gunderson, 1974; Nelson, 1965). Whatever criteria are adopted, however, adaptation to any environment is determined by the resources possessed by an individual or social group and the demand placed on the individual or group by the environment.

In this paper I will examine the utility of the experience of human exploration and habitation in the Antarctic as a model for the human exploration of Mars with a focus on patterns of adaptation and adjustment. I shall begin by providing a brief overview of the history of that experience, summarize the contemporary experience of Antarctic winter-over personnel, and conclude with an examination of the relevance of that experience for a manned mission to Mars.

History of Human Adaptation and Adjustment in the Antarctic

Antarctica has relevance to the space program not merely in terms of the synchronic examination of human factors in extended space missions but also in terms of the diachronic examination of processes of exploration and associated activities. Despite the obvious differences in history, technology, and objectives, the pattern of exploratory activity in Antarctica provides a useful analog for understanding processes of adaptation and adjustment at different stages in the human exploration of Mars.

The motives for the early exploration of Antarctica in the nineteenth

century were economic and scientific in nature. During the 1820s, American and European expeditions ventured into Antarctic waters in search of marine mammals for commercial use. British, French, and American expeditions in the 1840s sought to reach the South Magnetic Pole and conduct other, more general scientific observations in the southern latitudes. These early expeditions were characterized by competing claims of discovery, pursuit of "national" interests, danger, illness in the form of scurvy and starvation, exposure to the severe climate, and frequently, death itself. In essence, these expeditions represent the contact stage of exploration. Adaptation was measured strictly in terms of human survival and individual adjustment was characterized by the limited resources in coping with the severe environment.

The beginning of the "heroic era" of Antarctic exploration occurred with the Belgica expedition of 1898-99. The ship became trapped by the ice pack and drifted for a full year before being able to break free and return to civilization. Its crew was ill-prepared for the rigors of Antarctic life. As described by Sullivan (1957:36),

With the advent of continuous darkness came gloom and finally despair. Although confronted, as de Gerlache (the expedition leader) put it, with "a night of 1,600 hours," they had only lanterns to light their cramped compartments. Debilitation gradually brought the little group to the brink of disaster. They ate virtually no fresh food since the men found seal and penguin meat distasteful. Torpor and finally severe illness took hold of them. Danco, the magnetician, died of a heart attack aggravated by the severity of their life.

The men began grating on each other's nerves. They ran out of new stories and rebelled at hearing the same ones told over. There was not even a common language for conversation since, although the leaders were Belgian, half the crew was Norwegian, and the scientific staff included an American, a Rumanian, and two Russians.

Extreme weather, poor diet, interpersonal conflicts, and monotony of the environment combined to exact a heavy toll on the health and well-being of the expedition members.

Within fifteen years of the Belgica expedition, several attempts were made to explore the continent, the most famous being the race for the pole between Scott and Amundson. The different fates of these two expeditions are a testimony to the role of leadership, technology, sociocultural background, and personality in adapting and adjusting to an extreme, isolated environment. These factors and their influence on the outcome of each expedition have been well documented by Roland Huntford in his book The Last Place on

Earth. In it, Huntford notes that Scott's expeditions were characterized by Naval discipline with rigid segregation of officers and men. Amundson, on the other hand, exercised a 'spontaneous discipline' without formal hierarchy and rank. "Besides the fact that Amundson was leading a small expedition and Scott a large one, each was the product of his society" (Huntford, 1986:157).

While Amundson relied on sled dogs and skis to pursue his goal, Scott experimented with Manchurian ponies which perished in the cold and mechanized transport which failed miserably, before resorting to the inefficient and ultimately disastrous method of manhauling food and supplies. The rest is history. Nevertheless, for the men of these and the other expeditions during this era, adaptation and adjustment were truly of heroic proportions. Faced with starvation, extreme physical exhaustion due to frequent manhauling of supplies, depression, insomnia, exposure to the cold, wind and high altitude, and misfortune, that these expeditions accomplished anything is remarkable.

With the end of the heroic era, a new phase in the history of Antarctic exploration began, known as the "air age" because of the introduction of aircraft for transport and exploration. Adaptation and adjustment were facilitated by advances in technology (radio communication, airplanes, marine transport) and knowledge gained from the experience of previous expeditions. Polar expeditions became more efficient and less dangerous, and several important scientific discoveries were made. Nevertheless, stress was still a prominent feature of life "on the ice."

During the winter night, with a gymnasium and large library in addition to a busy work schedule, the inhabitants of Little America were well equipped to fight back the dark forces that threaten the minds of men confined for several months with a small group of companions. Nevertheless, the strain exposed psychological weaknesses and the slightest cause of friction became a major problem. One man could not eat unless he could find a seat in the mess hall out of sight of another whose chewing habits irritated him. "In a polar camp," wrote Byrd, "little things like that have the power to drive even disciplined men to the edge of insanity... I walked for hours with a man who was on the verge of murder or suicide over imaginary persecution by another man who had been his devoted friend" (Sullivan, 1957:83).

Byrd (1938) himself provides a vivid account of his own physical and psychological hardships experienced during a winter-over alone at Advance Base in 1934.

During the 1940s and 1950s, the human experience in Antarctica was distinguished by the construction of permanent stations, initiation of more sophisticated forms of scientific research, improvements in transportation

and communications, and the paradox of international cooperation and competing territorial claims. The organization for American expeditions during this period was assumed by the U.S. Antarctic Service (1939-41), the U.S. Navy (1946-55), and later the U.S. Antarctic Research Program (USARP) of the National Science Foundation. The concerted effort of several nations during the International Geophysical Year of 1957-1958 to establish permanent research stations and the establishment of the Antarctic Treaty of 1961 provided the foundation for patterns of adaptation and adjustment which are evident to this day. During this period, the quality of life among personnel assigned to Antarctic research stations improved markedly and the threat of starvation, exposure to the harsh environment, and accidental injury and death were significantly reduced by improvements in technology and station design and construction. In fact, the absence of much hardship and danger and the relative luxury of living conditions became sources of disappointment and disillusionment for many during this period (Gunderson, 1974).

Adaptation and Adjustment in Antarctica Today

Since the time of these early expeditions, the factors affecting adaptation and adjustment have undergone substantial changes. Improvements in logistics, communication with the outside world, station design and construction, transportation, and preparation have reduced the risk involved in working and living "on the ice." Nevertheless, certain aspects of adaptation and adjustment which characterized earlier expeditions remain today.

One factor influencing adaptation and adjustment which has remained constant throughout the different periods of exploratory activity has been the environment. Antarctica is the highest, coldest, driest, and windiest of the world's continents. Winter temperatures average -60F and winds exceeding 150 miles per hour are not uncommon. Plant and animal life are largely confined to the coastal regions. At the south pole, the atmospheric pressure is equivalent to an altitude of approximately 3353 meters above sea level in temperate zones. The mean annual temperature is -51C, and temperatures range from -17C down to -85C. The relative humidity is too low to permit accurate measurement. The annual seasons consist of one continuous day (summer) and one continuous night (winter), each lasting approximately six months (Natani and Shurley, 1974).

Traditionally associated with this harsh environment have been the

constant dangers of fire, frostbite, and getting lost in the dark (McGuire and Tolchin, 1961). However, with improvements in station facilities and technology, these are not considered important stressors. Rather, it is the social environment which is the most potent source of stress. In Antarctica, this social environment is characterized by prolonged isolation. Severe weather conditions during the austral winter prohibit travel to and from the continent and radio and satellite communication is frequently interrupted for extended periods. This isolation generates both external and internal stressors for station personnel. External stressors include difficulties in communicating with family or friends, real or imagined unpleasant events at home (Strange and Klein, 1974), and shortages in supplies or actions of authority that interfere with established routines or disappoint seemingly trivial expectations (Natani and Shurley, 1974). Internal stressors include the lack of privacy in cramped quarters, boredom due to the lack of environmental stimulation and interaction with the same limited number of individuals, sexual deprivation, reductions in the gratification of the basic human needs of affection, security, and feelings of personal significance, and the absence of statuses and roles which define one's social position in the outside world (Natani and Shurley, 1974; Rohrer, 1961).

Exposure to these social and environmental stressors results in numerous physiological and psychological changes among winter-over personnel. Dyspnea, anorexia, insomnia, and headaches are frequent symptoms at all Antarctic research stations. Arterial hypoxia, hyperventilation, and erythrocytosis are common in the high altitude environment of South Pole Station (Guenter, Joern, Shurley, and Pierce, 1970). The physiological changes incident to hypobaric hypoxia has resulted in several cases of acute mountain sickness with insomnia as a major symptom (Shurley, 1970). In one study, Muchmore and his associates (1970) reported a significant drop in the number of circulating leukocytes among personnel at South Pole Station throughout the winter. Immunoglobulin concentrations have also been found to undergo a significant decline during the Antarctic winter (Muchmore, Tatem, Worley, Shurley, and Scott, 1974), while increases in urinary catecholamine levels have been noted (Bodey, 1974).

It has been the psychological changes experienced by Antarctic personnel which have been given the greatest attention in previous studies, however. Gunderson (1968), for example, found that the incidence rates of psychiatric

hospitalizations among Navy personnel assigned to Antarctic duty was approximately three times higher than among Navy personnel in general. A program of psychological screening for all Operation Deep Freeze candidates has reduced the incidence of severe forms of mental disorder in the Antarctic since the early 1960s (Nardini, Herrmann, and Rasmussen, 1962). Nevertheless, psychological stress in the Antarctic is manifested in a common set of physical and emotional symptoms (Gunderson, 1963). Most individuals experience mild to moderate psychophysiological disturbances after several months of winter confinement with symptoms such as insomnia, irritability and aggression, anxiety, depression, impaired cognition, reduced motivation, gastrointestinal disorders, and musculoskeletal aches and pains. These symptoms appear to increase over time during the winter, peaking at mid-winter. Strange and Klein (1974) have grouped these symptoms into a general phenomenon known as the "winter-over syndrome." Alcohol-related problems have also been commonly but not universally reported in Antarctic stations (Blair, 1983).

In a modern urban context, the winter-over syndrome would be interpreted as symptomatic of physical or emotional illnesses and hence evidence of an inability to adapt to the environment. In the Antarctic, however, it represents the adaptation and exhaustion stages of Selye's (1956) general adaptation syndrome (Popkin, Stillner, Osborn, Pierce, and Shurley, 1978). Haggard (1964) concluded that men usually cannot adapt to extreme or extended isolation without showing some of the symptoms that typically characterize the mentally ill, suggesting that the absence of familiar, meaningful objects and relationships, as well as the presence of the unfamiliar produces the disturbances associated with isolation. Moreover, these disturbances are usually restricted to the station itself. A long-term follow-up study by Palinkas (1986) found no adverse effects of winter-over duty on the physical or mental health and performance of enlisted Navy personnel. In fact, winter-over personnel were found to have significantly fewer total first hospitalizations subsequent to their Antarctic duty than a control group of enlisted personnel who were accepted for Antarctic duty but who did not winter-over.

While the winter-over syndrome represents a common response to the physical and psychosocial stressors, there exist wide variations in the expression of this syndrome and the degree it adversely affects the health and performance of station personnel. Three sets of factors in particular appear to influence the process of psychosocial adjustment in all Antarctic

research stations. The first is observed in individual traits in station personnel. According to Biersner and Hogan (1984), adjustment is a function of narrow interests and a low need for social stimulation. Being interested in many hobbies and activities consistently predicts poor performance "on the ice" (Gunderson and Nelson, 1965). Extroverts are less successful at adapting to this environment than more inner-directed, quiet, retiring types (Strange and Youngman, 1971). Characterized as "educated isolates," self-sufficient, intelligent, calm, and independent (Kay, 1984; Palmai, 1963), these individuals score higher on performance evaluations and report for sick call significantly less often than more group-centered personnel (Palmai, 1963). Natani and Shurley suggest that "the isolates may thus individually and as a group establish internal routines and external expectations that seem idiosyncratic and immature or unrealistic to an outsider but are extremely important to the station party for structuring time, maintaining self-identity, and providing social security" (1974:110).

Second, the different cultural and subcultural backgrounds of station members appear to influence patterns of adaptation and adjustment. American stations, for instance, have been staffed by Navy personnel and civilian scientists. Individuals also are distinguished by differences in socioeconomic status, particularly education and occupation. Navy personnel are further differentiated by rank and occupation. Age differences and, as more women begin to winter-over, sex differences also characterize the social groups of all stations.

These differences in socioeconomic background are evident in different tastes in music, different hobbies and leisure activities, and values. Sociocultural differences also are reflected in coping styles. Civilians and enlisted personnel differ significantly in their psychological response to the Antarctic environment. These differences in adaptation are reflected in differences in health and performance. Navy personnel have been found to have lower job morale, much higher incidences of insomnia and depression, and more than twice the average number of sick call visits than civilians (Doll and Gunderson, 1971; McGuire and Tolchin, 1961). Other factors besides military or civilian status appear to affect styles and levels of adjustment to the Antarctic environment. Older individuals with middle and upper-middle class backgrounds who are well-educated generally display fewer emotional and physical complaints while "on the ice" than younger, less educated personnel

with lower or lower-middle class backgrounds (Gunderson, 1966).

The third set of influences on processes of adaptation and adjustment comprise the sociocultural systems or "microcultures" of the stations themselves. These systems differ from country to country, station to station, and even year to year as personnel rotate in and out of stations. Oftentimes, they are a reflection of individual personalities. Nevertheless, there are points of commonality and continuity. One element that almost all stations have in common is their scientific mission. Researchers engage in a wide variety of studies in the biological and medical sciences, meteorology and atmospheric sciences, earth sciences and glaciology, astrophysics and space sciences, and ocean sciences. Much of this work is tedious and exact, requiring long hours, laboratory and field work, and adherence to guidelines for research behavior layed out by each discipline. Station personnel are also engaged in support activities including facility maintenance and renovation, supply, construction, cooking, communications, and medical care. These activities at American stations have traditionally been assumed by U.S. Navy personnel but are increasingly being performed by civilian contractors.

Research stations also engage in similar forms of social behavior relating to leisure and recreation. Some of these activities take the form of rituals. At New Zealand stations, for instance, "packing" (stuffing one's trousers with snow) is a common form of initiation of personnel who are "on the ice" for the first time. Most stations have parties at certain times of the year, such as midwinter. More regular forms of entertainment include bull sessions, movies, reading, and drinking. The sociocultural systems of each station also share a value system which gives meaning to and orders the behavior of station members and which regulates social interaction. These values include motivations for Antarctic duty, valued personality characteristics, and rules for social behavior.

Also common to the sociocultural systems of Antarctic research stations are the processes of group formation and group conflict. Three distinct stages of group formation occur in these stations. In the first stage, the group is open, consisting of individuals who are removed from the direct influence of their accustomed sociocultural framework and are forced to intermingle with an extremely heterogeneous group. A common response to this situation is depression, loss of hope, and social withdrawal to "wait out" the winter (Natani and Shurley, 1974). The second stage involves subjective

exaggeration of the group heterogeneity and the formation of subgroups. The basis for formation varies considerably, sometimes age and authority, with an older group and a younger group; sometimes occupation with a scientific group and a military group; sometimes recreational interests with a drinking group and a nondrinking group. Clique formations have also been based on tastes in music (Strange and Youngman, 1971) and religious beliefs (Blair, 1983). The third stage is marked by "a period of intense personal social comparison, followed by the evolution of a new homogeneous microculture somewhat different from any of the microcultures originally represented by the individual men and adapted to this special environment" (Natani and Shurley, 1974:96). Despite this homogeneity, however, "at least one member is isolated from the group, or a peripheral clique forms even though most of the station are in the core group" (Strange and Youngman, 1971:257).

A critical part of this third stage is the formation of a group identity which appears to facilitate the adjustment process of individual members. This identity manifests itself in particular instances such as confrontations with outside authorities over delays in supply deliveries or changes in orders, emergencies, and at the end of the winter-over period when the station is "invaded" by replacement personnel who are regarded as "outsiders" lacking the experience and tradition of the community and unfamiliar with the rules of appropriate behavior "on the ice."

While the formation of a group identity can be attributed to the social comparison processes contributing to homogeneity, such processes can also produce conflict as well. In American research stations, group conflict has traditionally occurred between the military and the civilians. Underlying these conflicts are fundamental differences in lifestyles and values. Strickland (1964), for example, notes the inherent difference between the disciplined, regulated, conservative activities of the Navy personnel on the one hand and the relatively unstructured, disorderly, independent lifestyles of the scientists on the other. Age differences also lead to conflicts within a station. At one New Zealand station, for example, Taylor records that "the younger men complained that too much of the power rested with the older members of their party and that the recreational desires were so different as to be irreconcilable" (1974:426). Social conflicts also frequently occur between the core group of a station and individuals or small cliques whose values are widely divergent or whose behavior violates group

norms. Individuals who drink heavily, for example, are often viewed with suspicion and ostracised from the rest of the group. Individuals who are uncommunicative, hostile, moody, or who display poor personal habits also are subject to ostracism.

In addition to the differences of socioeconomic status, values, and lifestyles of station subgroups, social conflicts reflect two conflicting psychological needs -- the need to be part of a group and the need to distinguish oneself or be independent from the group. These conflicting psychological needs also carry with them different sets of demands on the individual. The self, for instance, demands a measure of autonomy, emotional gratification, and isolation. The social group, on the other hand, demands adherence to rules, cohesion, and mutual support. While individuals are able to negotiate these conflicting demands in the outside world, they are frequently unable to do so in the Antarctic.

Variations in psychosocial adjustment in the Antarctic occur because members have different psychological coping strategies and because they have different conceptions of self which are influenced by their relative position in the station microculture. Poor levels of adjustment occur when individuals are helpless or powerless in both a psychological and a social sense and are thus unable to negotiate the conflicting demands imposed by the self and the social group within the rules of behavior embedded in the cultural framework of the station. From a psychological perspective, extraverts cannot employ their coping strategy, which is based on the utilization of established networks of social support, to deal with the stressful environment because they are, for the most part, isolated from those supports which are back home. In addition, the value system of the station microculture which emphasizes self-sufficiency further weakens the efficacy of that strategy.

From a social perspective, those who adjust best are those who have the highest social status (i.e., highly-educated scientists who may do as they please and whose research is the raison d'être of the station itself). Navy enlisted personnel, on the other hand, perceive themselves to have a status which is subordinate to that of the civilians because they serve in a support capacity, and because they lack the autonomy possessed by the civilians. This status is examined by all station members through the process of social comparison and appears to play a role in the determination of one's own

perceived status and degree of control. "The Seabees' status and security, both based to a large extent on task accomplishment, may be threatened by the intimate presence of personnel with superior formal education who tend to evaluate their own performances on dimensions unfamiliar to Seabees" (Natani and Shurley, 1974:99). The social comparison processes occurs for both groups. Both evaluate their own status in relation to others and derive certain implications as to the amount of control they may exercise over their environment. Navy enlisted men often resent the autonomy of the civilians which they themselves lack. Navy officers, on the other hand, express the need for discipline and control.

Relevance of Antarctic Experience for Extended Missions to Mars

Of course, this is only a thumbnail sketch of the processes of adaptation and adjustment in the Antarctic. However, a few generalizations can be made on the basis of this overview regarding the utility of the human experience in Antarctica for an understanding of the human factors involved in one or more manned missions to Mars. For instance, we have already observed that the history of exploratory activity in the Antarctic provides a diachronic perspective of the processes of adaptation and adjustment. Such a perspective is essential for it demonstrates that certain aspects of the processes of adaptation and adjustment change over time while others remain relatively constant. The costs associated with manned missions and the logistical constraints imposed by time and space make it inevitable that the human exploration of Mars will be a prolonged endeavor occurring in discrete phases. These phases could conceivably have parallels to the stages of initial contact, the "heroic era," the "air age," colonialism, and settlement which characterize the exploration of Antarctica. As our brief review of the history of this exploration suggests, each phase of activity was marked by improvements in technology, transport, communications, and habitation as well as changes in organizational structure and mission objectives. All of these factors, in turn, had a profound influence on patterns of adaptation and adjustment. Issues of survival gradually gave way to issues of social compatibility, mental health, and accomplishment of scientific objectives. The human exploration of Mars may be expected to witness a similar evolution of patterns of adaptation and adjustment, although differences in criteria measures (i.e., definitions of adaptation, symptoms and stressors) will be

evident. The exploration of Mars may well have its own "heroic era" despite advances in technology and changes in organization. It may not assume the same form as it did in Antarctica; however, it will be heroic in the sense that organizational structure and individual behavior exhibited in the early stages of any exploratory effort must both face the anxiety and uncertainty of coping with a new and potentially hostile environment.

In addition, despite these improvements and changes, a certain continuity in these patterns of adaptation and adjustment may be expected due to the combined effects of physical and psychosocial stressors. The human experience in Antarctica has served to make us aware of several different features of this continuity. First, adaptation and adjustment reflect a synergistic effect of physical and emotional stressors. Insomnia among winter-over personnel, for instance, reflects a response to certain combined features of the physical (i.e., high altitude, extreme variations of dark and light) and social (i.e., lack of social stimulation, interpersonal conflict, isolation from family and friends) environment. A similar synergistic effect associated with conditions such as space adaptation syndrome and desynchronization may be expected to occur in extended manned missions (Conners, Harrison, and Atkins, 1986).

Second, the criterion measures of adaptation and adjustment are inter-related. Task performance may readily be affected by physiological changes associated with an extreme environment such as acute mountain sickness, arterial hypoxia, or neutropenia resulting in insomnia or poor health. Lack of environmental stimulation may result in impaired cognitive performance. Social compatibility may be affected by symptoms of depression or hostility associated with poor emotional health.

Third, all three aspects of adaptation and adjustment are influenced by several different factors, some of which may change over time, and others which are expected to remain relatively constant. Among these factors are the following:

- * Objectives and goals
- * Philosophy and value systems
- * Personnel composition
- * Organization
- * Technology
- * Physical Environment

* Sociocultural Environment

* Temporal Characteristics

Each of these factors have also been identified as being relevant for the planning and operational phases of extended space missions (National Academy of Sciences, 1972; Sells and Gunderson, 1971). The utility of the human experience in the Antarctic as a model for extended manned missions to Mars, therefore, must be evaluated on the basis of the degree of similarity or difference of each of these factors in the two contexts.

Finally, an evaluation of the human experience in the Antarctic brings to our attention the realization that the criteria used to assess adaptation and adjustment are based on two different and at times contradictory sets of definitions. The first set is comprised of organizational or normative definitions and is based on mission objectives and the expectations of bureaucrats and "experts" as to how these objectives should be performed. The second set is comprised of operational or pragmatic definitions and is based on the actual experience of mission participants and their willingness and ability to adjust to contingencies and unforeseen events. As the expectations and organizational structure become altered in light of actual experience, the two sets of definitions become similar but perhaps never isomorphic. Although interrelated, these two sets of definitions are governed by different priorities which must be acknowledged and understood before any serious efforts at a manned mission and planetary exploration of Mars can occur.

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